*REMARKS*

Claims 1 through 27 are pending.

Claims 1, 5, 12, 20 and 24 have been amended to more distinctly claim the invention. Support for the amendments to claims 1, 12 and 20 can be found, for example, in the specification at page 7, lines 2 through 7 and Figure 1.

Attached hereto is a marked up version of the changes made to the claims by the current amendment. The attached pages are captioned "Version with Markings to Show Changes Made."

No new matter has been added.

The Applicants respectfully request reconsideration of the present application in view of the above amendments and the following remarks. Some of the technical differences between the applied references and embodiments of the invention will now be discussed. Of course, these discussed differences regarding the embodiments, which are disclosed in detail in the specification do not define the scope or interpretation of any of the claims. Instead, when presented, such differences are offered merely to help the Examiner appreciate important claim distinctions as they are discussed.

In the event that the arguments presented below and the aforementioned amendments do not cause this application to proceed to allowance, Applicants respectfully request that the amendments made to claims 1, 5, 12, 20 and 24 be made of record for purposes of Appeal.

Applicants do not consider that the amendments made to claims 1, 5, 12, 20 and 24 should give rise to a further search of related art. These amendments were made to more distinctly claim the presently pending subject matter as explained in detail below.

### *Objection to Claims 5-8 and 24-27*

Claims 5-8 and 24-27 are objected to as being misleading. The Office Action states that the phrase "one of the support" implies more than one claimed support.

Claims 5 and 24 have been amended to more clearly define that which Applicants consider the invention. The offending phrases have been removed and substituted with equivalent language "either the support or the source(s)."

Therefore, claims 5 and 24 are in an allowable form. Claims 6-8 and 25-27 that depend from claims 5 and 24, respectively, are similarly allowable based upon the allowability of claims 5 and 24 and further in view of the additional limitations recited in the dependent claims.

Reconsideration and withdrawal of this objection is respectfully requested.

### *Rejection of Claims 1-4, 9, 10 and 12-27 under 35 U.S.C. § 103(a)*

Claims 1-4, 9, 10 and 12-27 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Todokoro and in view of U.S. Patent No. 6,166,380, issued to Kitagawa et al. (hereinafter "Kitagawa"). Applicants respectfully traverse this rejection.

Generally, the disclosed invention is directed towards an apparatus useful for determining the three-dimensional profile(s) of a semiconductor device, i.e., a silicon chip. For example, in one aspect of the invention, the controller 70 controls the electron gun 30 and the lenses 31 and 33 to produce an electron beam 34 having a selected depth of focus. The drive unit 42 moves the stage 40 into position beneath the electron gun 30 and moves the stage in the Z direction so that the electron beam 34 is focused on a selected portion of the semiconductor substrate 20. The drive unit 42 then moves the stage 40 in the X and Y directions to scan the electron beam 34 in a series of parallel paths across the semiconductor substrate 20, producing the secondary beams 51 that are received by the electron detectors 50 and processed by the processor 73.

It should be noted that the secondary beams 51 (51a and 51b of Figure 1, for example) are ***reflected*** from the ***surface*** of the semiconductor substrate ***without passing through any semiconductor device material such as a side wall***. For example, at page 7, lines 2 through 7 of the specification, it is stated that:

> The term secondary beam is used herein to refer to electron beams reflected by and/or emitted by the semiconductor substrate 20. For purposes of clarity, two secondary beams 51 (shown as 51a and 51b) are shown in Figure 1, though it will be understood that the secondary electrons may form other beams that travel in directions other than those shown in Figure 1.

This is a distinction over U.S. Patent No. 6,114,695, issued to Todokoro et al. (hereinafter "Todokoro") where secondary beams ***are reflected through the semiconductor material*** and detected ***after*** the reflected secondary beams ***pass through the semiconductor material***, i.e., a side wall, as explained in more detail below.

In one embodiment, the disclosed invention is an apparatus for determining a dimension of a feature of a semiconductor device. The apparatus includes at least one source of electrons, a focusing device and a support. The focusing device is positioned proximate to the source of electrons to focus electrons emitted by the source and form an electron beam. The focusing device focuses the electron beam to a first depth and then a second depth of focus to form at least one representation of the semiconductor device corresponding to electrons focused at the first and second depths of focus and impinging on the ***surface*** of the semiconductor device. The support is aligned with the electron beam and includes a support surface to engage the semiconductor device and support the semiconductor device. Either one of the electron beam and the support are movable relative to the other in any of the x, y, or z planes.

In contrast to the present invention, Todokoro pertains to methods to measure profiles of materials, e.g., semiconductor chips, by passing high energy electrons onto the material and measuring the reflected electrons that ***pass through*** the profiled areas of the material, i.e., a side wall. For example at column 1, lines 49 through 63, Todokoro states that:

> Referring to FIG. 2, problems encountered in observing a deep hole with the conventional scanning electron microscope will be described. FIG. 2 shows a case where a primary electron beam 1 of low energy irradiates a flat portion and a hole 3 of a specimen. Thanks to the absence of any obstacles, almost all of the number of secondary electrons 2 generated at the flat portion can be detected. Similarly, reflection electrons concurrently discharged can also be detected. ***In the case of irradiation of the hole 3, however, generated secondary electrons 2 impinge on the side wall of the hole 3 and consequently cannot escape from the hole 3 to the outside.*** The energy of reflection electrons is higher than that of secondary electrons but is ***not so high that the reflection electrons can penetrate through the side wall, and the reflection electrons are thus blocked by the side wall***. (Emphasis added.)

Continuing at column 2, lines 41 through 66, Todokoro states that:

> In the present invention, in order to solve the aforementioned problems, a primary electron beam is used which has such high energy as to allow reflection electrons generated at the bottom of a hole ***to penetrate through the side wall of the hole.***
>
> Referring to FIG. 1, the principle of observation of deep holes by using a primary electron beam of high energy will be described.
>
> A case where a primary electron beam 4 of high energy irradiates a surface portion resembles a case where the surface portion is irradiated with low energy. However, in the case of irradiation on the interior of a hole, the circumstances differ greatly. Secondary electrons 2 are absorbed by the side wall ***but reflection electrons 6 penetrate through the side wall to escape from the surface***. When the reflection electrons 6 pass through the surface, they generate secondary electrons 5. Since the secondary electrons 5 and reflection electrons 6 have more information about the bottom of the hole 3, an image of the interior of the hole can be obtained by detecting these electrons.
>
> Thus, one of the aspects of the present invention resides in that the primary ***electron beam has sufficiently high energy to allow reflection electrons to penetrate through the side wall, thereby permitting observation of the bottom of high-aspect-ratio holes, which observation has hitherto been impossible***. (Emphasis added.)

Thus, Todokoro discloses a method that differs significantly from the presently claimed invention that utilizes electrons that are ***reflected from the surface of the semiconductor device***.

Todokoro does not teach or suggest, provide any motivation or an expectation of success to one having ordinary skill in the art to utilize electrons focused at a first and second depths of focus that impinge upon the ***surface*** of a semiconductor device. In contrast, the teachings of Todokoro are

directed to use of electrons that are reflected and ***pass through the side wall*** of profiled portions of semiconductor devices.

Neither does Todokoro teach or suggest, provide any motivation or an expectation of success to one having ordinary skill in the art to utilize a first focusing device positioned proximate to a first port and adjacent a first electron beam to focus a first electron beam on a ***first position surface*** and a second focusing device positioned proximate to a second port and adjacent a second electron beam to focus the second electron beam on a ***second position surface*** that is different from the first position. Furthermore, Todokoro does not teach or suggest, provide any motivation or an expectation of success to one having ordinary skill in the art to utilize a first focusing device positioned proximate to a first source of electrons to focus a first electron beam emitted from the first source on a ***first position surface*** and a second focusing device positioned proximate to a second source of electrons to focus a second electron beam emitted from the second source ***on a second positions surface***.

Although Kitagawa may disclose the use of an x-y-z stage, Kitagawa does not remedy the deficiencies of Todokoro. The combination of Kitagawa and Todokoro would provide a method to three-dimensionally scan semiconductor devices by subjecting the device to an electron beam of sufficient energy that would allow the reflected electrons ***to pass through the wall(s)*** of profiled portions of the device. In fact, the use of an x-y-z stage may defeat the concept disclosed by Todokoro, in that, it appears that the formulae developed by Todokoro are based on movement in only the x-y plane. The three-dimensional profiling discussed by Todokoro is based on the reflected electrons that pass ***through the profiled portions*** of the semiconductor device and their respective angles of capture. (See, for example, column 14, lines 32 through 44 which specifically discuss movement ***only*** in the x-y plane and column 31, line 55 through column 32, line 27 that implies that one variable (the z axis) should be held constant to develop the three-dimensional profile of the "hole".)

This is in fact a teaching away from the instantly claimed invention.

Neither Todokoro or Kitagawa, alone or in combination, teach or suggest, provide any motivation or an expectation of success to one having ordinary skill in the art to utilize electrons focused at a first and second depths of focus that impinge upon the ***surface*** of a semiconductor device. Neither does Todokoro or Kitagawa, alone or in combination, teach or suggest, provide any motivation or an expectation of success to one having ordinary skill in the art to utilize a first focusing device positioned proximate to a first port and adjacent a first electron beam to focus a first electron beam on a ***first position surface*** and a second focusing device positioned proximate to a second port and adjacent a second electron beam to focus the second electron beam on a ***second position surface*** that is different from the first position. Lastly, Todokoro nor Kitagawa, alone or in combination, do not teach or suggest, provide any motivation or an expectation of success to one having ordinary skill in the art to utilize a first focusing device positioned proximate to a first source of electrons to focus a first electron beam emitted from the first source on a ***first position surface*** and a second focusing device positioned proximate to a second source of electrons to focus a second electron beam emitted from the second source ***on a second positions surface***.

Reconsideration and withdrawal of this rejection is respectfully requested.

***Rejection of Claims 5-8 under 35 U.S.C. § 103(a)***

Claims 5-8 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Todokoro and Kitagawa as applied to claim 1-4 above, and further in view of U.S. Patent No. 4,447,731, issued to Kuni et al. (hereinafter "Kuni"). Applicants respectfully traverse this rejection.

The discussions and arguments set forth above with regard to the teachings of Todokoro and Kitagawa are incorporated in their entirety and are reiterated here.

Claim 5, indirectly dependent from independent claim 1, pertains to use of a third detector operatively coupled to either the support or the source to detect movement of the support or the source to generate a third signal which corresponds to the movement detected.

Claim 6, dependent from dependent claim 5, further provides a memory device coupled to at least one of the detectors to store the signal generated by the detector. Claim 7, dependent from dependent claim 5, provides for graphically displaying the voltage generated by the first and second electron flows of electrons. Claim 8, also dependent from dependent claim 5, is directed to a printing device that prints a representation of the voltage generated by the first and second electron flows of electrons as a function of the movement detected by the third sensor.

Kuni does not remedy the deficiencies of either Todokoro or Kitagawa, alone or in combination. Kuni discloses an apparatus for determining the profile of a semiconductor wafer by passing a single electron beam across the surface of the object. Kuni fails to teach or suggest that multiple electron beams focused at different depths of focus, and hence, two or more depths of focus of electron beams could provide useful information regarding the three-dimensional ***surface*** aspects of the semiconductor wafer.

None of the references, alone or in combination, teach or suggest, provide any motivation or an expectation of success to one having ordinary skill in the art that an apparatus that utilizes multiple focused electron beams could be used to determine the three-dimensional profile of a semiconductor device based on electrons reflected from the ***surface(s)*** of a semiconductor device. Therefore, none of

the references, alone or in combination, teach or suggest to one having ordinary skill in the art that the measurement of two or more depths of focus of multiple electron beams could be used with a memory device to store the signals, or to display the voltages or to print a representation of the voltage generated by the first and second flows of electrons as a function of the movement detected by a third sensor.

Therefore, claims 5-8 are in allowable form. Reconsideration and withdrawal of the pending rejection is respectfully requested.

***Conclusion***

In view of the foregoing, Applicants submit that all pending claims distinguish over all references cited by the Examiner and respectfully requests that all rejections be withdrawn. The Examiner is invited to telephone the undersigned attorney for Applicants in the event that such communication is deemed to expedite prosecution of this application.

Respectfully submitted,

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## VERSION WITH MARKINGS TO SHOW CHANGES MADE

1. (Twice Amended) An apparatus for determining a dimension of a feature of a semiconductor device, comprising:

at least one source of electrons;

a focusing device positioned proximate to the source of electrons to focus electrons emitted by the source and form an electron beam, the focusing device focusing the electron beam to have a first depth and a second depth of focus and form at least one representation of the semiconductor device corresponding to electrons focused at the first and second depths of focus and impinging on [the] <u>one or more surfaces of the</u> semiconductor device;

a support aligned with the electron beam and having a support surface to engage the semiconductor device and support the semiconductor device, one of the electron beam and the support being movable relative to the other of the electron beam and the support in any of the x, y, or z planes.

5. (Amended) The apparatus of claim 4, further comprising a third detector operatively coupled to <u>either</u> [one of] the support [and] <u>or</u> the source to detect movement of <u>either</u> [the one of] the support [and] <u>or</u> the source, the third detector generating a third signal corresponding to movement detected thereby.

12. (Twice Amended) An apparatus for determining a dimension of a feature of a semiconductor device, comprising:

a source of electrons;

a port surface having a first and second ports therethrough, the first port being positioned proximate to the source to form a first electron beam when electrons pass therethrough, the second port spaced apart from the first port to form a second electron beam when electrons pass therethrough;

a first focusing device positioned proximate to the first port and adjacent the first electron beam to focus the first electron beam on a first position surface;

a second focusing device positioned proximate to the second port and adjacent the second electron beam to focus the second electron beam on a second position surface that is different from the first position; and

a support aligned with the first and second ports and having a support surface to engage the semiconductor device and support the semiconductor device at the first and second positions, one of the support and the source being movable relative to the other of the support and the source in any of the x, y, or z planes.

20. (Twice Amended) An apparatus for determining a dimension of a semiconductor device feature, comprising:

first and second sources of electrons;

a first focusing device positioned proximate to the first source of electrons to focus a first electron beam emitted from the first source on a first position surface;

a second focusing device positioned proximate to the second source of electrons to focus a second electron beam emitted from the second source on a second positions surface; and

a support aligned with the first and second focusing devices and configured to engage the semiconductor device, one of the support and the sources of electrons being movable relative to the other of the support and the sources of electrons in any of the x, y, or z planes.

24. (Amended) The apparatus of claim 23, further comprising a third detector operatively coupled to either [one of ] the support [and] or one of the sources to detect movement of either [the one of] the support [and] or one of the sources, the third detector generating a third signal corresponding to movement detected thereby.